

CLAIMS:

What is claimed is:

1. A method for creating instruction bundles,
5 comprising:
 receiving an instruction group having one or more
 instructions;
 determining a number of each possible type of
 instruction in the one or more instructions of the
10 instruction group; and
 creating one or more instruction bundles based on
 the number of each possible type of instruction in the
 one or more instructions of the instruction group.
- 15 2. The method of claim 1, wherein receiving an
 instruction group having one or more instructions
 includes receiving a stream of intermediate instructions
 organized into instruction groups.
- 20 3. The method of claim 1, further comprising gathering
 information about an architecture for use in creating
 instruction bundles.
4. The method of claim 3, wherein the information
25 includes at least one of a number of each type of
 execution unit available in the architecture and a number
 of bundles that can be dispatched concurrently by the
 architecture.
- 30 5. The method of claim 2, wherein the steps of
 determining a number of each possible type of instruction
 and creating one or more instruction bundles is performed

1905, 1906, 1907, 1908, 1909, 1910, 1911, 1912, 1913, 1914, 1915, 1916, 1917, 1918, 1919, 1920, 1921, 1922, 1923, 1924, 1925, 1926, 1927, 1928, 1929, 1930, 1931, 1932, 1933, 1934, 1935, 1936, 1937, 1938, 1939, 1940, 1941, 1942, 1943, 1944, 1945, 1946, 1947, 1948, 1949, 1950, 1951, 1952, 1953, 1954, 1955, 1956, 1957, 1958, 1959, 1960, 1961, 1962, 1963, 1964, 1965, 1966, 1967, 1968, 1969, 1970, 1971, 1972, 1973, 1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 25

5

1) instructions of the same instruction type will preserve there original order;

10

3) for architectures where a number of M execution units is equal or less than a number of concurrent bundles, MM templates will only be used when there are three or fewer instructions remaining in the group;

15

5) MBB and BBB templates are avoided when only a single B instruction remains.

20

25

30

less restrictive instruction type placement.

10. The method of claim 1, wherein determining a number of each possible type of instruction in the one or more instructions of the instruction group includes incrementing instruction counters based on the number of each possible type of instruction in the one or more instructions, and wherein creating one or more instruction bundles includes decrementing the instruction counters as instructions are added to instruction bundles.

11. The method of claim 7, wherein the most common instruction combination is where all instructions in the instruction group are of a memory instruction type, integer instruction type or integer arithmetic logic unit type.

12. The method of claim 1, wherein creating one or more
20 instruction bundles includes ensuring that creating the
one or more instruction bundles does not introduce
hardware oversubscription.

13. The method of claim 12, wherein ensuring that
25 creating the one or more instruction bundles does not
introduce hardware oversubscription includes forming
partial instruction bundles.

14. An apparatus for creating instruction bundles,
30 comprising:

means for receiving an instruction group having one or more instructions;

means for determining a number of each possible type of instruction in the one or more instructions of the instruction group; and

means for creating one or more instruction bundles
5 based on the number of each possible type of instruction
in the one or more instructions of the instruction group.

15. The apparatus of claim 14, wherein the means for receiving an instruction group having one or more instructions includes means for receiving a stream of intermediate instructions organized into instruction groups.

16. The apparatus of claim 14, further comprising means
15 for gathering information about an architecture for use
in creating instruction bundles.

17. The apparatus of claim 16, wherein the information includes at least one of a number of each type of execution unit available in the architecture and a number of bundles that can be dispatched concurrently by the architecture.

18. The apparatus of claim 15, wherein the means for
25 determining a number of each possible type of instruction
and means for creating one or more instruction bundles
operate on each instruction group in the stream of
intermediate instructions.

30 19. The apparatus of claim 14, wherein the means for
creating one or more instruction bundles operates in view
of one or more of the following rules:

1) instructions of the same instruction type will preserve there original order;

2) branches will normally appear only in the final bundle of an instruction group;

5 3) for architectures where a number of M execution units is equal or less than a number of concurrent bundles, MM templates will only be used when there are three or fewer instructions remaining in the group;

10 4) instructions are taken in order of their flexibility in terms of where that instruction can be placed in the available bundle types; and

5) MBB and BBB templates are avoided when only a single B instruction remains.

15 20. The apparatus of claim 14, wherein the means for creating one or more instruction bundles creates the one or more instruction bundles based on a most common instruction combination first.

20 21. The apparatus of claim 20, wherein the means for creating one or more instruction bundles creates the one or more instruction bundles based on a most restrictive instruction type placement and proceeds to less restrictive instruction type placement second.

25 22. The apparatus of claim 14, wherein the means for creating one or more instruction bundles creates the one or more instruction bundles based on a most restrictive instruction type placement and proceeds to less
30 restrictive instruction type placement.

23. The apparatus of claim 14, wherein the means for

00339 57250

determining a number of each possible type of instruction in the one or more instructions of the instruction group includes means for incrementing instruction counters based on the number of each possible type of instruction in the one or more instructions, and wherein the means for creating one or more instruction bundles includes means for decrementing the instruction counters as instructions are added to instruction bundles.

24. The apparatus of claim 20, wherein the most common instruction combination is where all instructions in the instruction group are of a memory instruction type, integer instruction type or integer arithmetic logic unit type.

25. The apparatus of claim 14, wherein the means for creating one or more instruction bundles includes means for ensuring that creating the one or more instruction bundles does not introduce hardware oversubscription.

26. The apparatus of claim 25, wherein the means for ensuring that creating the one or more instruction bundles does not introduce hardware oversubscription includes means for forming partial instruction bundles.

27. A computer program product in a computer readable medium for creating instruction bundles, comprising:

first instructions for receiving an instruction group having one or more instructions;

second instructions for determining a number of each possible type of instruction in the one or more instructions of the instruction group; and

third instructions for creating one or more instruction bundles based on the number of each possible type of instruction in the one or more instructions of the instruction group.

5

28. The computer program product of claim 27, wherein the first instructions for receiving an instruction group having one or more instructions includes instructions for receiving a stream of intermediate instructions organized
10 into instruction groups.

29. The computer program product of claim 27, further comprising fourth instructions for gathering information about an architecture for use in creating instruction
15 bundles.

30. The computer program product of claim 29, wherein the information includes at least one of a number of each type of execution unit available in the architecture and
20 a number of bundles that can be dispatched concurrently by the architecture.

31. The computer program product of claim 28, wherein the second instructions for determining a number of each
25 possible type of instruction and third instructions for creating one or more instruction bundles are executed on each instruction group in the stream of intermediate instructions.

30 32. The computer program product of claim 27, wherein the third instructions for creating one or more instruction bundles are executed in view of one or more

FOR THE

5

15

10

20

25

30

30

35. The computer program product of claim 27, wherein the third instructions for creating one or more instruction bundles creates the one or more instruction bundles based on a most restrictive instruction type

placement and proceeds to less restrictive instruction type placement.

36. The computer program product of claim 27, wherein
5 the second instructions for determining a number of each possible type of instruction in the one or more instructions of the instruction group includes instructions for incrementing instruction counters based on the number of each possible type of instruction in the
10 one or more instructions, and wherein the third instructions for creating one or more instruction bundles includes instructions for decrementing the instruction counters as instructions are added to instruction bundles.

15 37. The computer program product of claim 33, wherein the most common instruction combination is where all instructions in the instruction group are of a memory instruction type, integer instruction type or integer
20 arithmetic logic unit type.

38. The computer program product of claim 27, wherein the third instructions for creating one or more instruction bundles includes instructions for ensuring
25 that creating the one or more instruction bundles does not introduce hardware oversubscription.

39. The computer program product of claim 38, wherein the instructions for ensuring that creating the one or
30 more instruction bundles does not introduce hardware oversubscription includes instructions for forming partial instruction bundles.